Deric Tay | Regional Channel Manager - Asia

AUGUST 2017

Geospatial Technology in Sustainable Oil Palm Production

Transforming the Way the World Works

- Using spatial technologies, our customers gain significant economic breakthroughs and at the same time improve quality, safety, regulatory compliance and reduce environmental impact
- Solutions span positioning and sensing, global connectivity, 3D design, modeling & measurement, machine and process automation, machine learning and powerful data analytics
- Founded in 1978, headquartered in Silicon Valley, 2016 Revenue US $2.4 Billion; 7,000+ employees

Positioned to Meet a Global Market

PARTNERS IN 110 COUNTRIES

CUSTOMERS IN 150 COUNTRIES

OFFICES IN 35 COUNTRIES

GLOBAL RESEARCH & DEVELOPMENT CENTERS IN 15 COUNTRIES AND 12 TIME ZONES

SALES, SUPPORT & SERVICE NETWORKS IN 125 COUNTRIES

Trimble Technology Evolution

Positioning & Sensors

- Scanning Total Station
- Scanner
- Total Station
- RFID
- Soft GNSS
- GNSS Receiver
- Image capture
- Laser tools
- Machine control

Connectivity

- Cell
- Radio
- IP
- WiFi
- Bluetooth
- Satellite

Modeling

- Virtual Reality
- Field Inspection
- 3D modeling
- Point cloud
- Visualization
- Project Management
- Mechanical design
- Structural design
- Clash Detection

Analytics

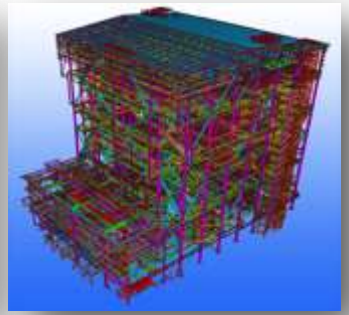
- Asset Optimization
- Work Management
- Yield Management
- Fleet analytics
- Driver safety
- Environmental
- Cost analysis
- Time analysis
- Road/rail alignment
- Design coherency

Full Solutions

Core Industry Focus

Agriculture

Civil Engineering & Construction



Building Construction

Geospatial

Transportation & Logistics

Emerging Businesses

Rail

Water Utilities

Forestry

Electric Utilities

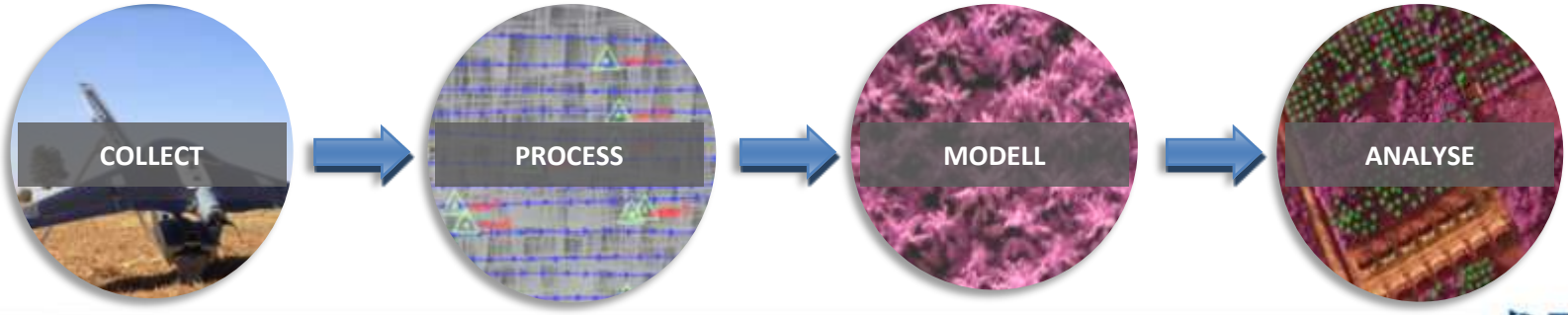
Field Service

Land Administration

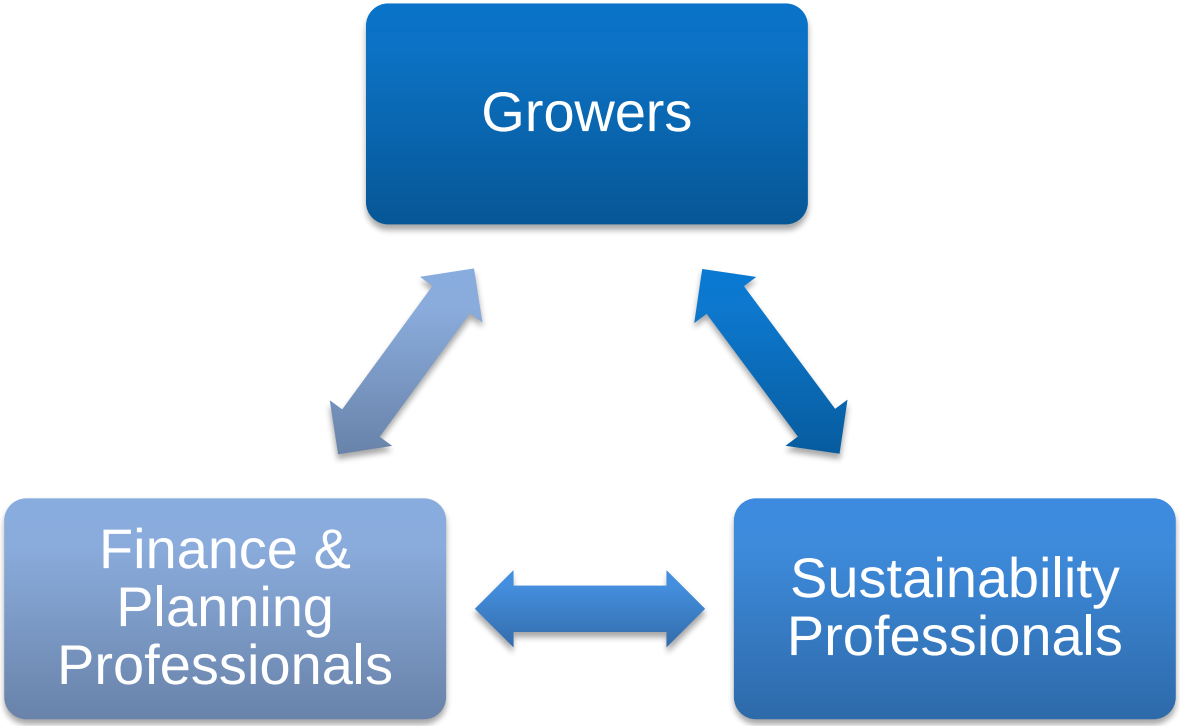
Oil Palm & Plantations

Trimble‘s Oil Palm Solution

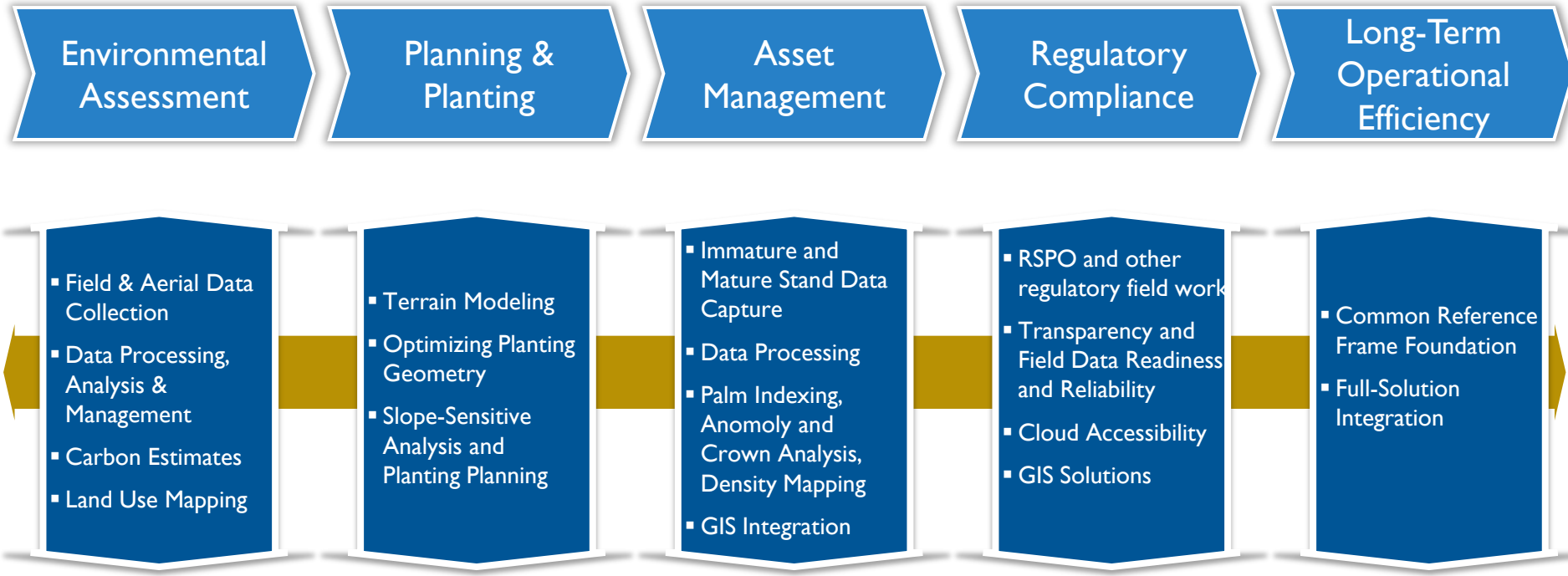
- **Combines Trimble hardware and software to create a complete Geospatial ecosystem for the plantation**
  - **Supports an informative, repeatable workflow that creates actionable intelligence for multiple parties.**
  - **The solution is born out of close consultation with plantation managers (growers), sustainability professionals and financial planners**



Who is our FOCUS?



Addressing the Plantation Lifecycle



Solution Explanation – Infrastructure First *!*

i.e. UX5 HP

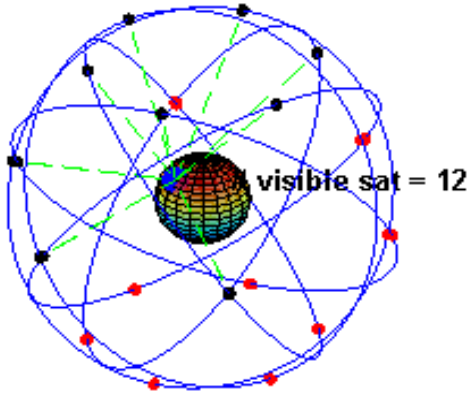
- **A base station (Trimble R9S GNSS Receiver) underpins the entire data collection workflow as a continuously operating reference station (CORS) running at a central location**
- UAV aerial … op-down" vi… cultivat… infra…
- Trimb… GNS… …ield data c… …ered from the air
- All data is collected using the CORS a common reference frame, helping "future-proof" the data collection process by allowing data collected at different intervals to comm…

What do you mean?

What is “GNSS” and why is it important for palm oil?

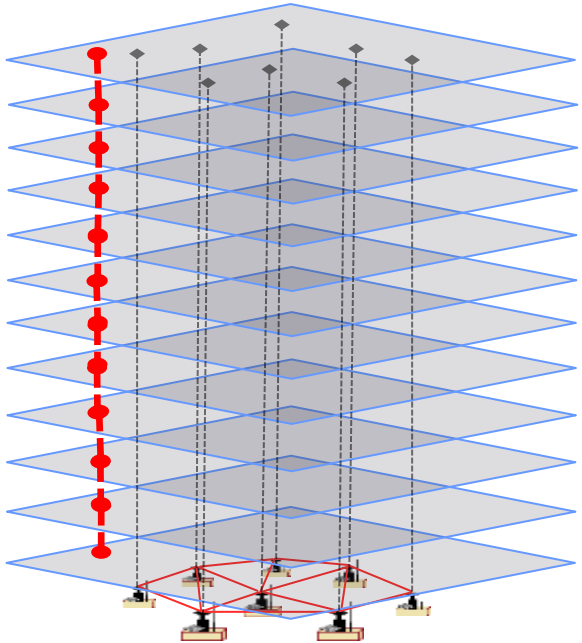
GNSS = Groups of positioning satellite constellations =

GPS	30 (current)
GLONASS	24 (current)
Galileo	27 (2019)
QZSS	3 (2013)
COMPASS	35 (2020)
IRNSS	10+ (2014)

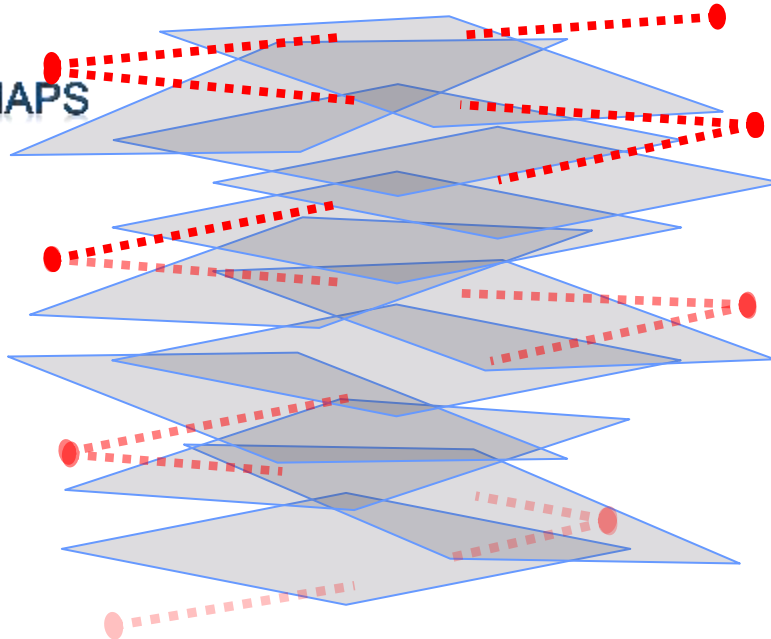


Today, most plantations and industry participants use spatial data, most of which is captured using global positioning devices….but it is collected inefficiently and unsustainably – that’s a big problem for an industry that needs to produce more output without increasing its land use. Appropriate use of GNSS technology can enable us to do more with the same resources!

Here's why plantations need a Spatial Data Infrastructure



TRUCK ROUTING
ENDANGERED SPECIES MAPS
WATER AND ELECTRICITY
BOUNDARY DISPUTES
BUFFER ZONES
SMALL HOLDER PLOTS
CONSTRUCTION WORKS
SOIL SAMPLES
BLOCK DATA
ESTATE BOUNDARIES
TOPOGRAPHIC DATA
PROPERTY BOUNDARIES



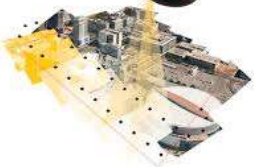
Data layers *with* a Reference Frame

= spatial "dialogue"

Data layers *without* a Reference Frame

Solution Explanation - Collect

i.e. UX5 HP OR
any other UAV



- Trimble R9S GNSS Receiver underpins the entire data collection workflow as a continuously operating reference station (CORS) running at a central location
- UAV aerial data collection captures the “top-down” view of the plantation, inclusive of cultivated areas, mills, roads and other infrastructure, and small-holder plots
- Trimble high-accuracy Geo7X and Catalyst GNSS solution support new and ongoing field data collection work that cannot be covered from the air
- All data is collected using the CORS a common reference frame, helping “future-proof” the data collection process by allowing data collected at different intervals to commonly align

Solution Explanation – Process, Model

i.e. UX5 HP

i.e. TBC Base

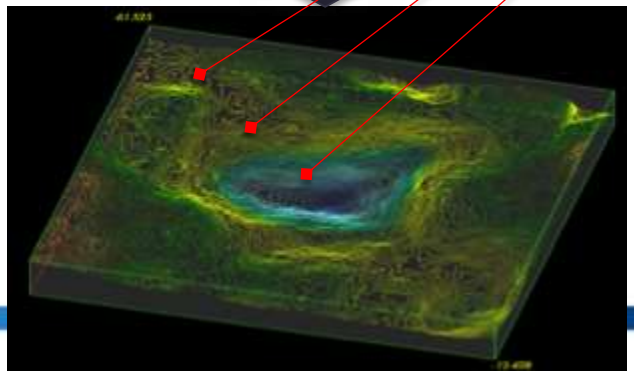
i.e. UASMaster or TBC APM

- Trimble Business Center Aerial Photogrammetry Module (TBC) processes aerial data to create:
  - Orthomosaic photo
  - Digital Terrain Model
  - Digital Surface Model
- Additional modeling can highlight slope thresholds, boundary/buffer encroachment, and precision planting models
- Reference frame transformation

Solution Explanation – Process, Model

3D Planting

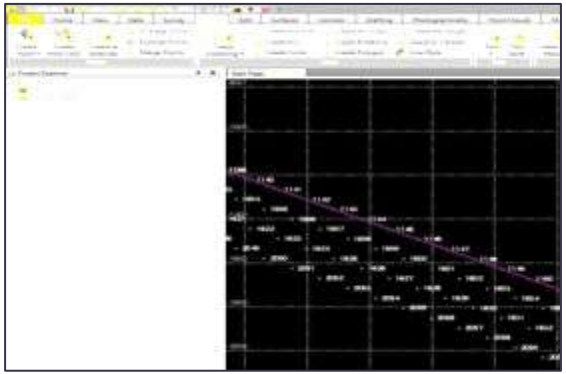
- *Triangle planting model automation in TBC, DTM used for Slope Variance Identification*
- *Office-to-Field Navigation and Planting Workflow*



Slope (°)	Slope (%)	Effective density
5-10°	8.7-18	135-151
10-15°	18.0-27	151-153
15-20°	27.0-36	153-155
20-25°	[illegible]	155-158

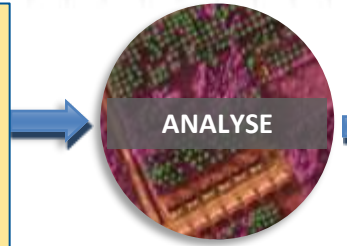
Density (palms/ha)	Terraces		Flat land	
	Palm	Terrace	Palm	Row
120	10.4	7.9	9.81	8.5
136	9.3	7.9	9.21	7.98
148	8.5	7.9	8.83	7.65
160	7.9	7.9	8.5	7.36

Slope %	Slope Deg	Uncorrected Distance (m)	Corrected Density (palms/ha)	Corrected Distance (m)
0	0	9.21	136	9.21
9	5	9.17	137	9.25
18	10	9.07	140	9.35
27	15	8.9	146	9.53
36	20	8.65	154	9.8
47	25	8.35	166	10.16



Solution Explanation – Analyse, Action

- Trimble eCognition Oil Palm Module uploads orthophoto, digital terrain and digital surface models
- Automatically generated deliverables include
  - Individual palm count and indexing, including XY coordinates, height and a unique palm ID
  - Palm crown size analysis
  - Anomalous palms that likely have health or growth problems - key indicators of disease!
  - Palm density
- Data flows easily into GIS systems already in use at the plantation or at a corporate level
- Automatic tool provides a easily understood snapshot of the situation on the ground



eCognition
Oil Palm Application

Decision making and management action !

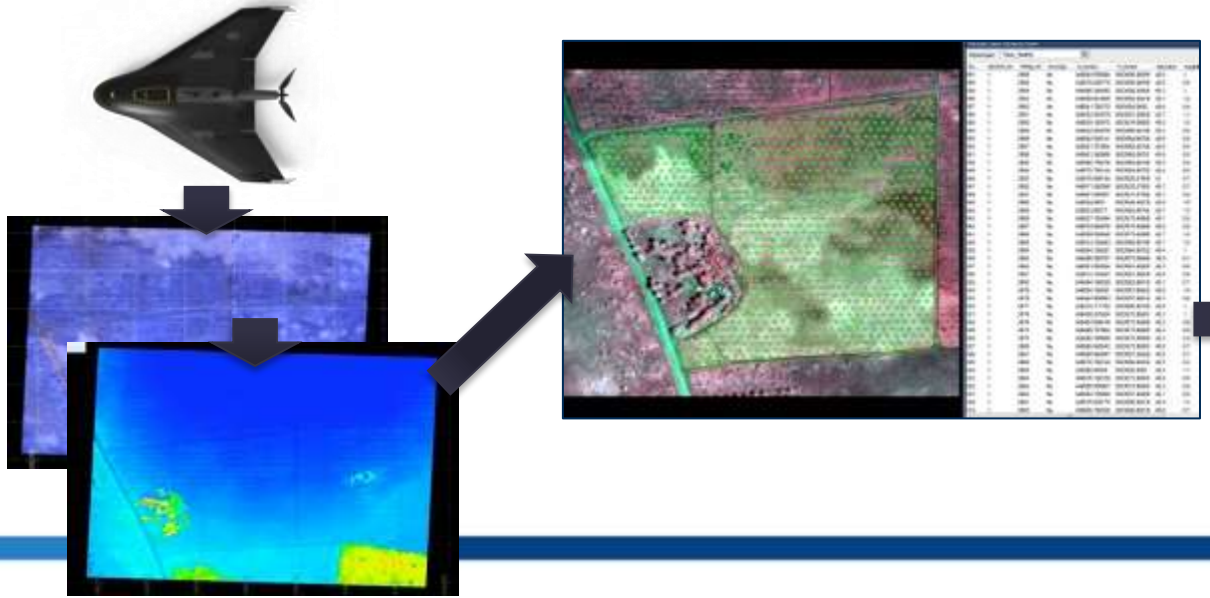
Trimble

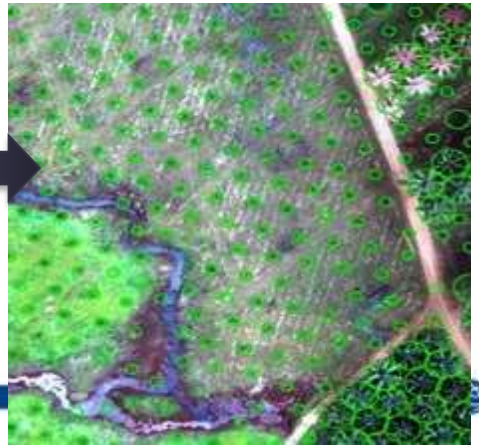
Video link

http://infogeospatial.trimble.com/2017-7-12eCog_RecordedWebinarRegistrationConfirmation.html

Solution Explanation – Immature Palms

Surface and Terrain Model Generation for Growth Monitoring, Irrigation & Maintenance Palm Counting, Anomaly Identification, Geotagging, export to GIS, Density Mapping





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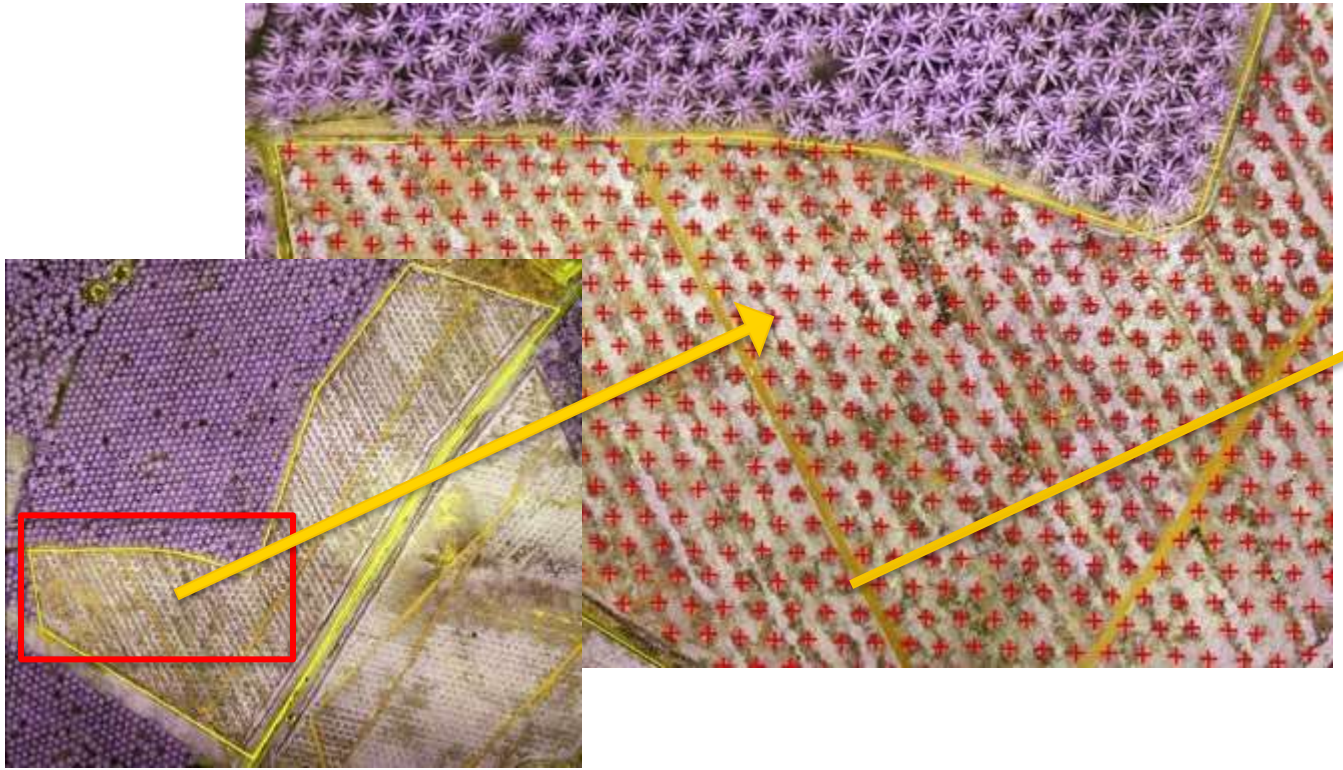
Solution Explanation – Analyse, Action



Palm ID + Coordinates and attributes

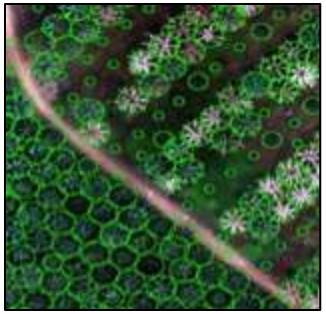
Solution Explanation – Mature Stand

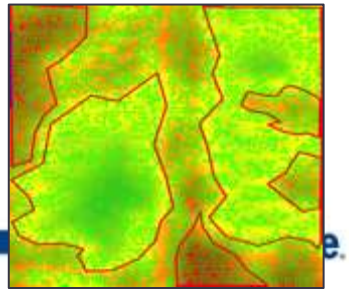
Terrain Model Generation for Irrigation & Maintenance

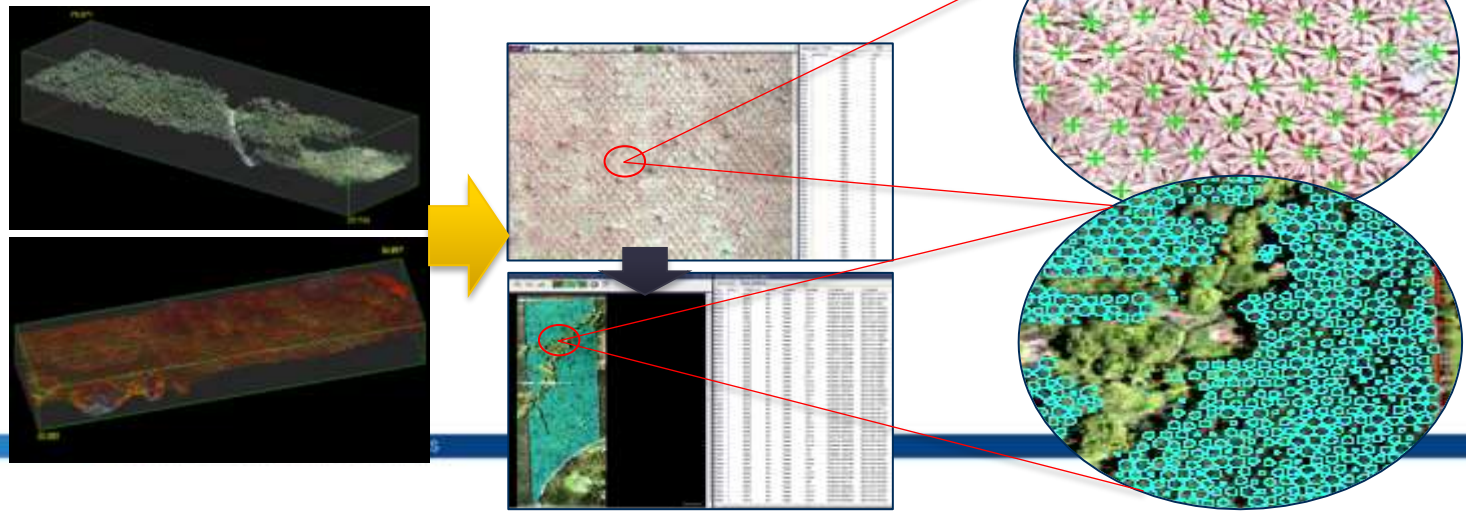
Palm Counting and Indexing, Anomaly Detection

Density Mapping & Polygon Extraction

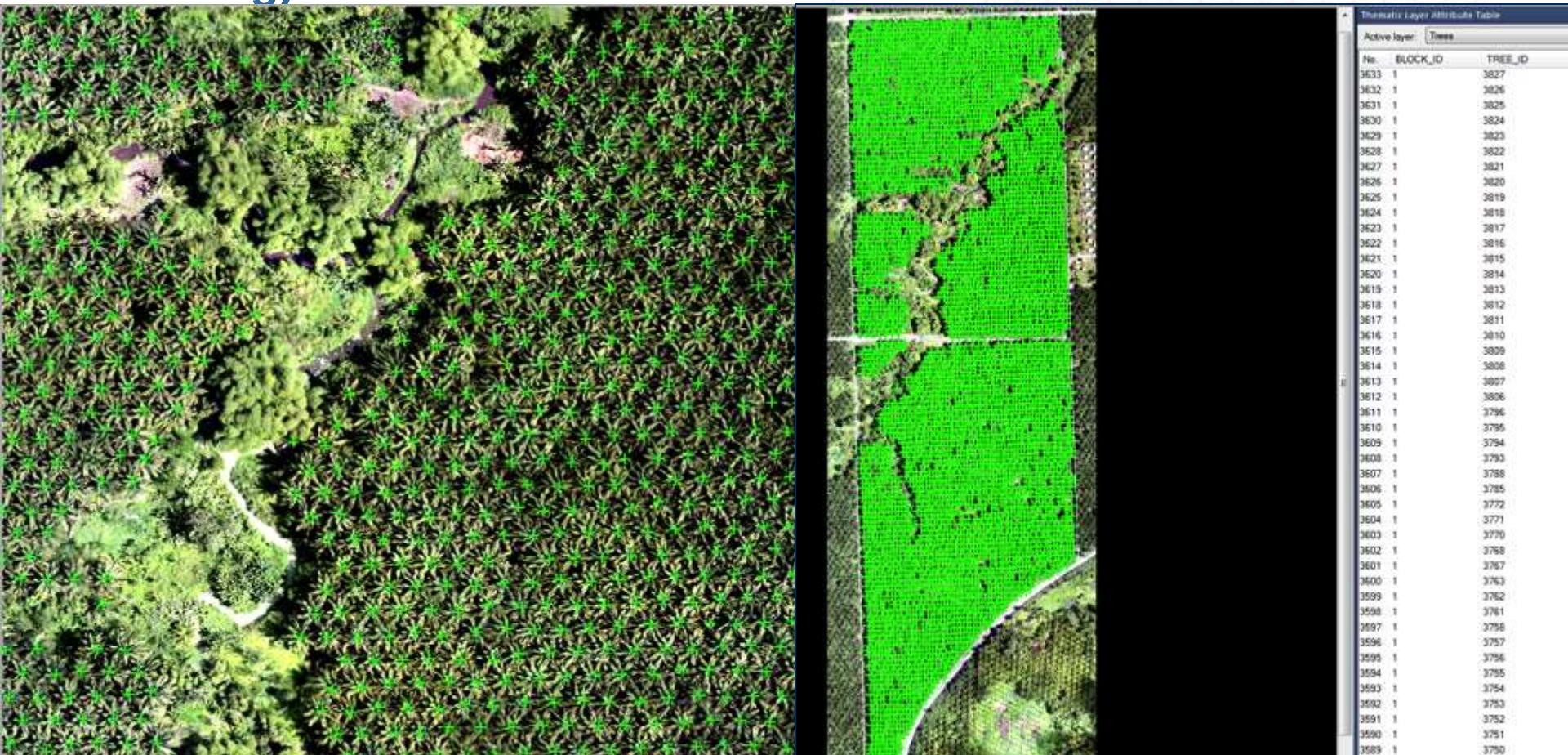
Overlay existing GIS Layers





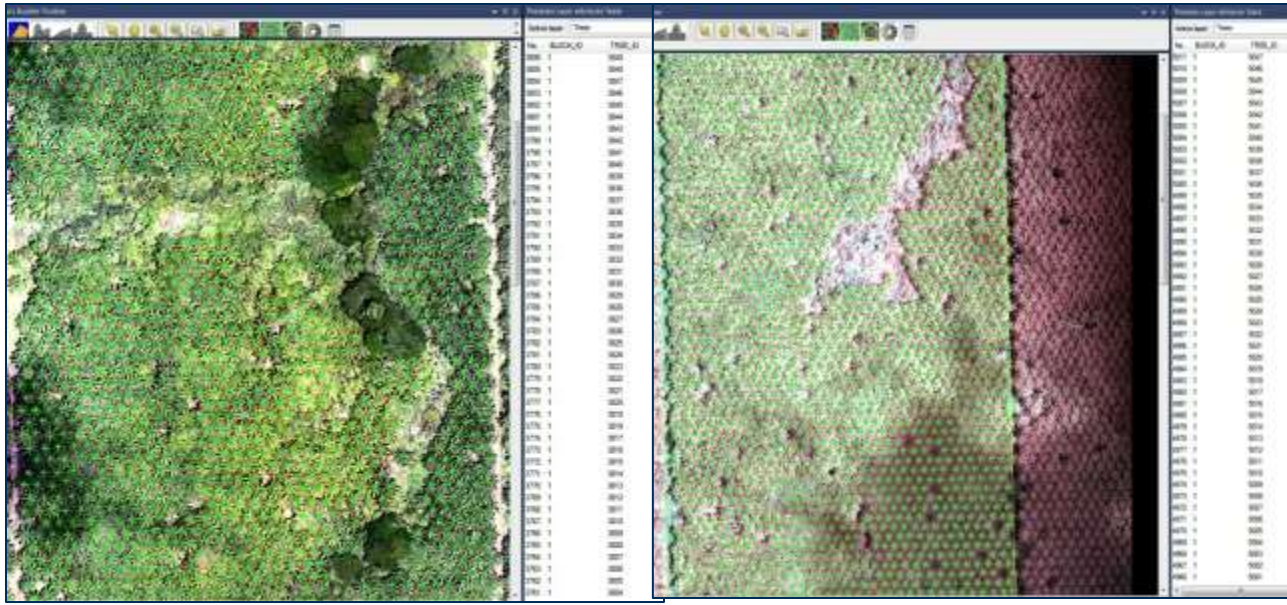


Example: Large Block Mature Stand (Palm Counting & Indexing)



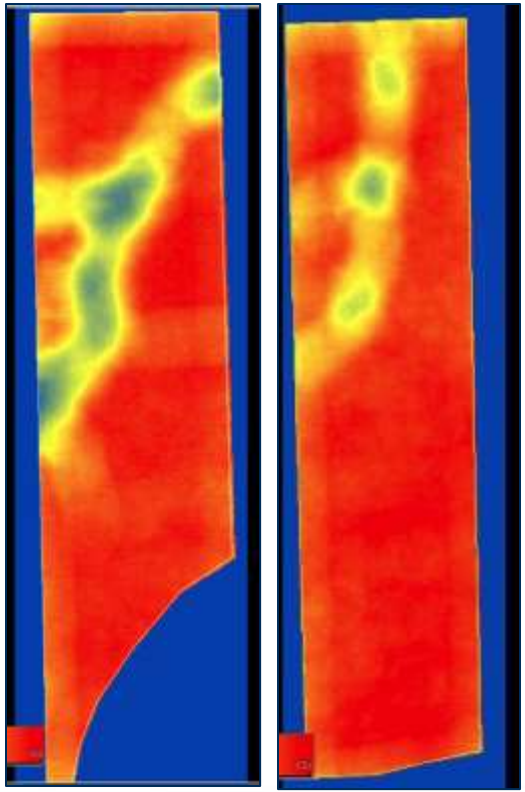
Example: Large Block Mature Stand (Palm Counting & Indexing)

BLOCK ID	Total Area (ha)	Total Number of Palms	Palms/ha
xc0240	30.39	3534	116.29
xc0250	35.11	4634	131.99
xc0260	38.95	5011	128.65
xc0270	40.19	4854	120.78
xc0290	40.56	4681	115.41
xc0300	40.41	4687	115.99
xc0340	28.9	3454	119.52
xc0350	34.26	3806	111.09
AVG			118

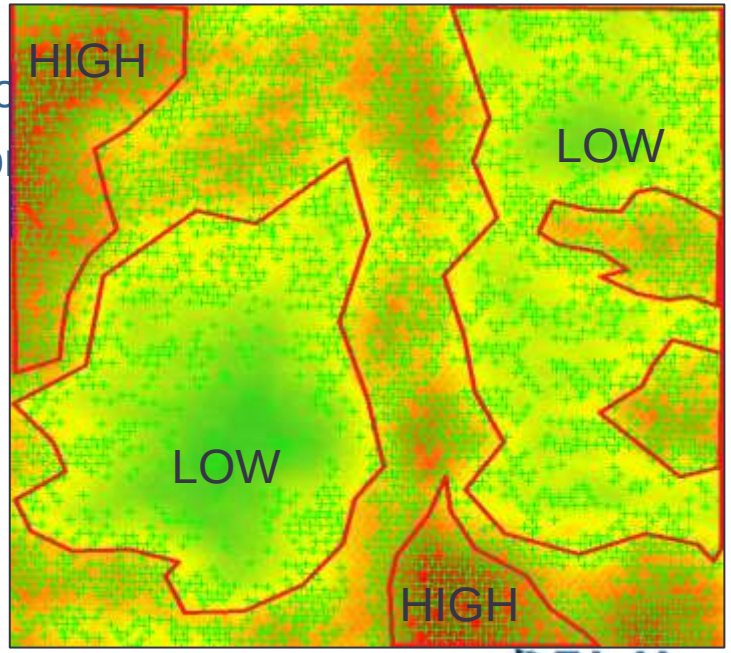


Compatibility Across RGB and NIR Imagery

Example: Mature Stand Density



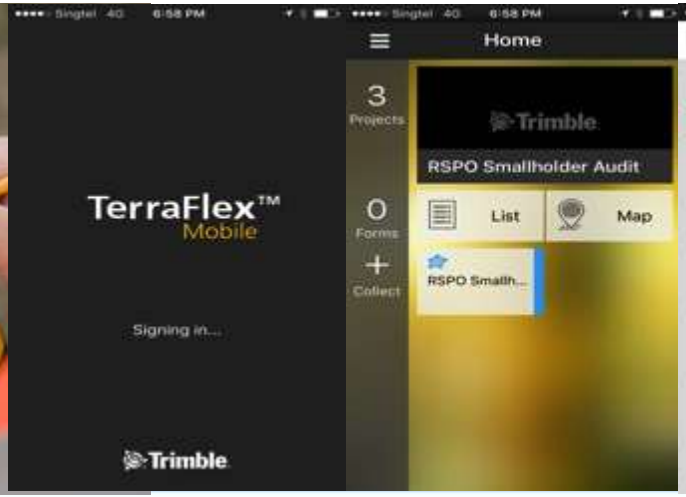
- Helps identify underutilized areas of each block
- Easily cross-referenced or overlaid with other software output
- Ideal for Small-holder plo
- Can be used for valuatio



Small Holder Management

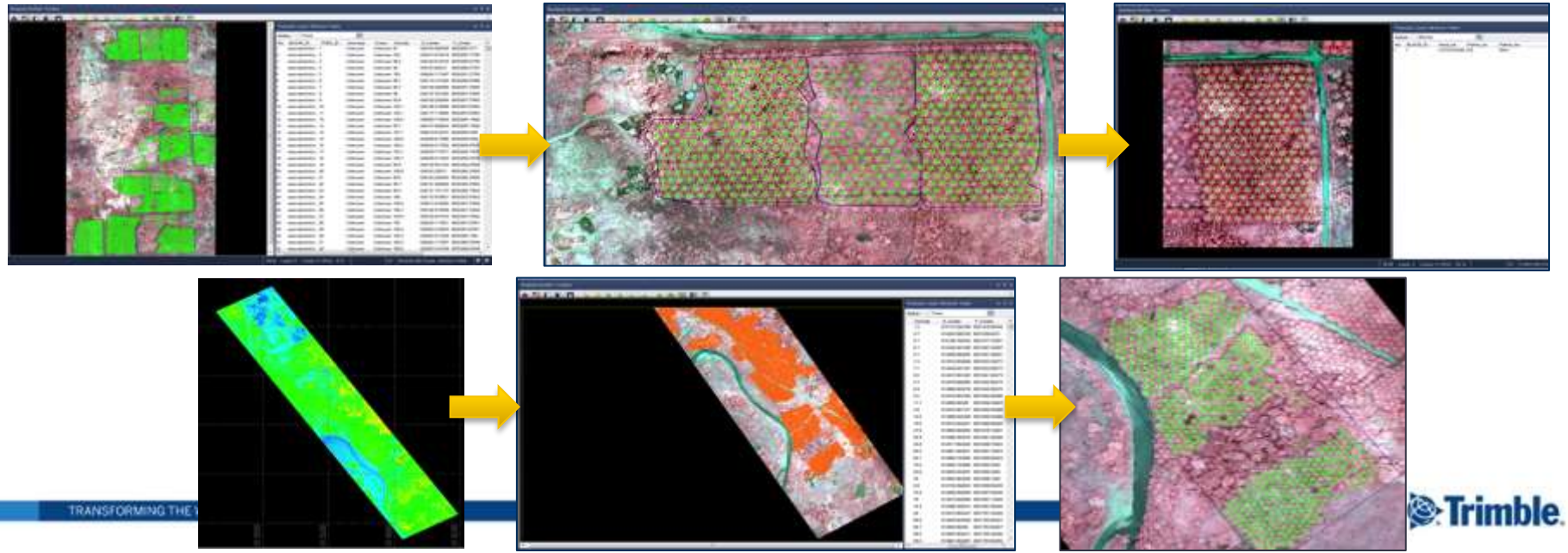
Small Holder Mapping & Regulatory Compliance

- *RSPO & other regulatory bodies' workflow entirely digitized*
- *Small holder plot surveying utilizing high accuracy mapping equipment and CORS*
- ***Land rights and small holder block analysis***



Small Holder Management

Identify disease, Identify Productive and Unproductive Small Holders – HUGE SAVINGS!!!!



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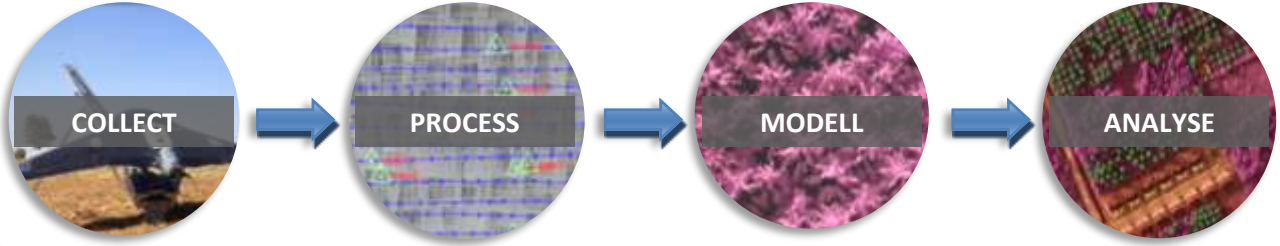
Solution Explanation – Actionable, Repeatable



- "Actionable" spatial data flows back to the plantation managers to support operational efficiency across a team of agronomists, sustainability, planning and procurement specialists, and field crews
  - Example "Field check palm 783847, block 8 – anomalous, short"
- Process is repeated annually of semiannually and changes are observed to track progress

2 Core Value Propositions

(1) Reduce Operating Expenses

(2) Environment and Regulatory Requirements

Long-term Operational Efficiency – Sustainability Professionals!

FERTILIZER	NITROGEN BASED?	2015 Tonnage	%TTL
Urea - (46.5%N)	YES	-	0%
Urea	YES	19,049	38%
Urea	YES	14,112	28%
Urea "S" - (40.5%N, 4.8%S)	YES	-	0%
Ammonium Sulphate - (21% N)	YES	-	0%
Ammonium Sulphate - (21% N)	YES	-	0%
AGRICULTURAL Ammonium Chloride (25% N)	YES	-	0%
AGRICULTURAL Ammonium Chloride (25% N)	YES	-	0%
Ammonium Nitrate (33.5 / 34 % N)	YES	-	0%
Diammonium phosphate - (18%N, 46%P205)	YES	-	0%
30.6% N, 5.7% P, 6.9% S	YES	-	0%
Triple Super Phosphate		3,528	7%
Monoammonium Phosphate (11%N, 52%P205)	YES	-	0%
Sulfate of Potash		-	0%
Potassium Chloride (KCL - 60% K20)		9,096	18%
Magnesium Sulfate (26% Mgo, 21% S)		-	0%
Magnesium Sulfate (26% Mgo, 21% S)		-	0%
Magnesium Sulfate (26% Mgo, 21% S)		1,675	3%
Ground Magnesium Limestone		-	0%
Sodium Borate (48%B)		456	1%
NPK 15% N, 15% P, 6% K, 4% Mg	YES	-	0%
NPK 15% N, 15% P, 15% K	YES	1,848	4%
NPK 16% N, 16% P, 16% K	YES	288	1%
NPK 12% N, 12% P, 17% K, 2% Mg	YES	288	1%
Sulphur - (100%)		168	0%
TTL		50,508	

Nitrogen-based Fert into Test Sites	Planned	Actual
#palms/ha	130	118
Total Area	9000	9000
Total Palms	1,170,000	1,062,000
Total Fertton/palm (kg)	43.1692	47.5593
Oversupply of Fert/palm	0	4.3901
Excess Tonnage		4,662.28

Long-term Operational Efficiency – Growers & Financial Professionals

FERTILIZER	NITROGEN BASED?	2015 Tonnage	%TTL	Price ($)/ton	TTL ($)/BLOCK
Urea - (46.5%N)	YES	-	0%	0	
Urea	YES	19,049	38%	$175	$3,333,575
Urea	YES	14,112	28%	$175	$2,469,600
Urea "S" - (40.5%N, 4.8%S)	YES	-	0%		
Ammonium Sulphate - (21% N)	YES	-	0%		
Ammonium Sulphate - (21% N)	YES	-	0%		
AGRICULTURAL Ammonium Chloride (25% N)	YES	-	0%		
AGRICULTURAL Ammonium Chloride (25% N)	YES	-	0%		
Ammonium Nitrate (33.5 / 34 % N)	YES	-	0%		
Diammonium phosphate - (18%N, 46%P2O5)	YES	-	0%		
30.6% N, 5.7% P, 6.9% S	YES	-	0%		
Triple Super Phosphate		3,528	7%	$288	$1,016,064
Monoammonium Phosphate (11%N, 52%P2O5)	YES	-	0%		
Sulfate of Potash		-	0%		
Potassium Chloride (KCL - 60% K2O)		9,096	18%	$400	$3,638,400
Magnesium Sulfate (26% Mgo, 21% S)		-	0%		
Magnesium Sulfate (26% Mgo, 21% S)		-	0%		
Magnesium Sulfate (26% Mgo, 21% S)		1,675	3%	$150	$251,250
Ground Magnesium Limestone		-	0%		
Sodium Borate (48%B)		456	1%	$460	$209,760
NPK 15% N, 15% P, 6% K, 4% Mg	YES	-	0%		
NPK 15% N, 15% P, 15% K	YES	1,848	4%	$420	$776,160
NPK 16% N, 16% P, 16% K	YES	288	1%	$420	$120,960
NPK 12% N, 12% P, 17% K, 2% Mg	YES	288	1%	$420	$120,960
Sulphur - (100%)		168	0%		
TTL		50,508	100%		$11,936,729

Plantation Censuses and Historic Planting Densities Drive Fertilizer Purchasing

Estimated Excess Fertilizer Purchases of 10.5% based on sample data….that means OPEX could be reduced, and can be identified on a block by block basis

This result can drive lower OPEX and higher Yields!!!!

This plantation is saving $1,748,000 per year

Trimble

Challenges

- Corporate structure
  - Spatial technology as “leverage”
  - Spatial technology is esoteric?
  - Spatial technology is expensive?
- GIS Integration at the Plantation level, not just corporate level
- Identifying how to “take it to the next level”
- Future development needs
  - Carbon stock, peat identification, address vs. coordinate, etc.

www.trimble.com

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